European Commission

Joint Research Centre

webKORIGEN: Web-based Nuclide Depletion Calculations

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www.jrc.ec.europa.eu

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Stimulating innovation
Supporting legislation

webKORIGEN history

ORIGEN:	Oak Ridge Isotope Generation and Depletion Code
ORIGEN2:	A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code
KORIGEN:	Karlsruhe ORIGEN, optimized for German reactors
webKORIGEN:	Version of KORIGEN driven by the EU-web-portal Nucleonica, with a subset of KORIGEN features

Purpose:

- Calculate fuel nuclide inventory changed by neutron interactions and decays

webKORIGEN fields of application:

- From the initial amount and composition of a nuclear fuel and a given irradiation history it determines the fuel nuclide inventory changed by neutron interactions and decays
- Initial actinides daughters and FP are considered
- n-interactions: (n,f), (n,γ), (n,2n), (n,3n)
- Decays: α, β-, β+, internal transitions

- Calculated Quantities for Nuclides and Chemical Elements:
  - Concentrations (mol or g)
  - Radioactivities (Bq)
  - Total and γ-heat releases (W)
  - Radiotoxicities for ingestion and inhalation (Sv)
  - Gamma and neutron emission rates (γ/s, n/s)

webKORIGEN features:

- Follow-up of nuclide generation in a neutron field (reactor, irradiation facility) and during subsequent decay, including re-processing
- Easy-to-use Graphical User Interface:
  menus, toolbars, online help
- Easy input preparation restricted to simple basic applications
- A subset of full KORIGEN features, dedicated data libraries
- Fast graphical output generation

Accessing webKORIGEN

1. Select Applications->webKORIGEN from the Nucleonica's main menu

OR

2. Go to the Nuclear Science Applications Portal and select webKORIGEN from the application list

nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser

Version: 2012.06.28 08:29:37

webKORIGEN

Questions, remarks, suggestions can be posted in the forum

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given initial reactor fuel or a single target nuclide, it calculates the time evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear properties such as masses, radioactivities, heat releases, radiotoxicities, emission of radiation, etc...

Step 1: Calculation Mode | Step 2: Reactor / Operation | Step 3: Input Summary and Run | Step 4: Display Results | Step 5: Log files | Step 6: Parameters

- Reactor irradiation
  - Power
  - Flux
- Decay
- Reactor irradiation and decay
- Reactor irradiation, cooling, reprocessing and decay of waste

webKORIGEN calculations step by step

STEP 1: Selecting the computation mode

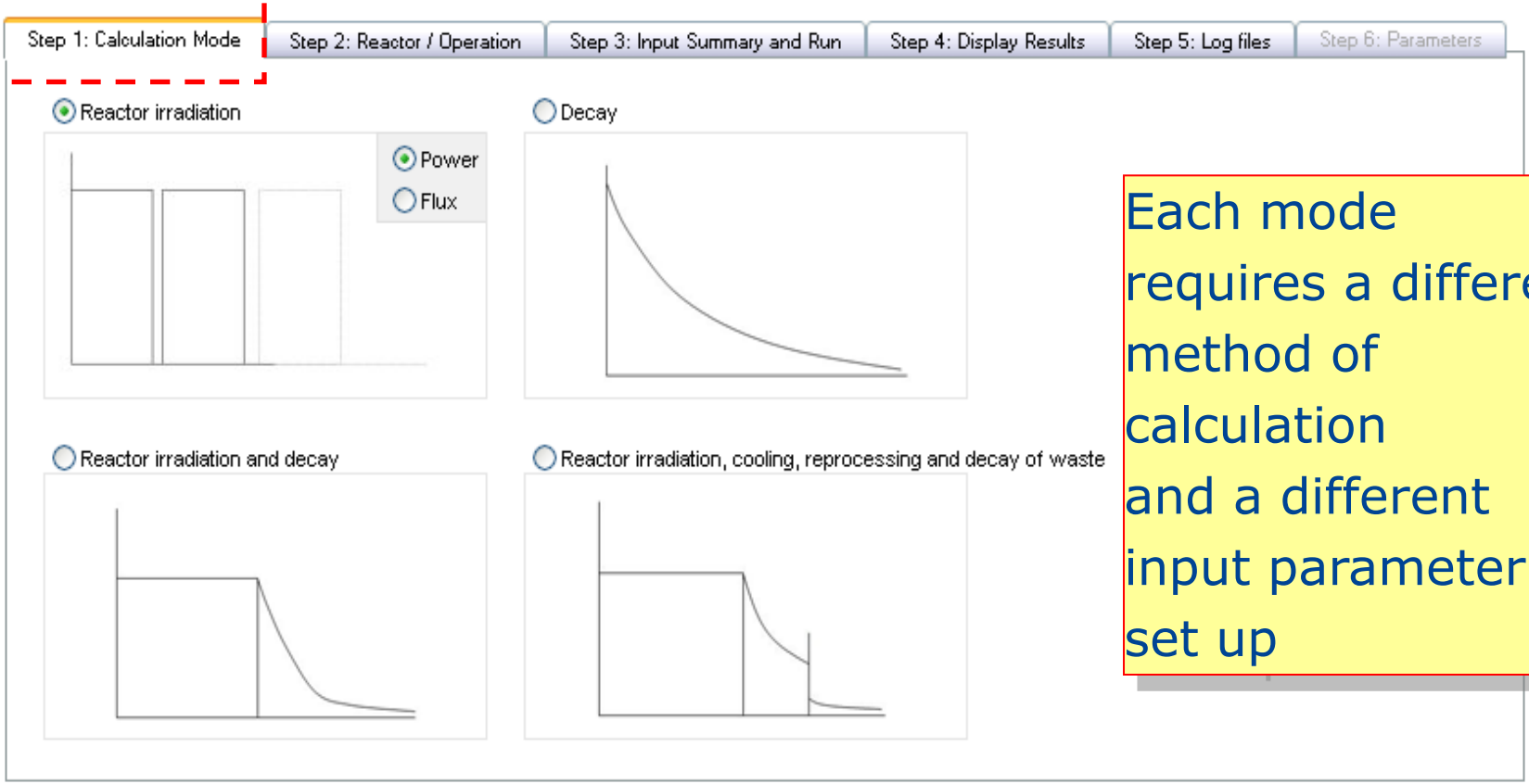
STEP 2: Set up of mode-dependent input parameters

STEP 3: Display of input summary and start of the execution

STEP 4: Display results

webKORIGEN calculations step by step

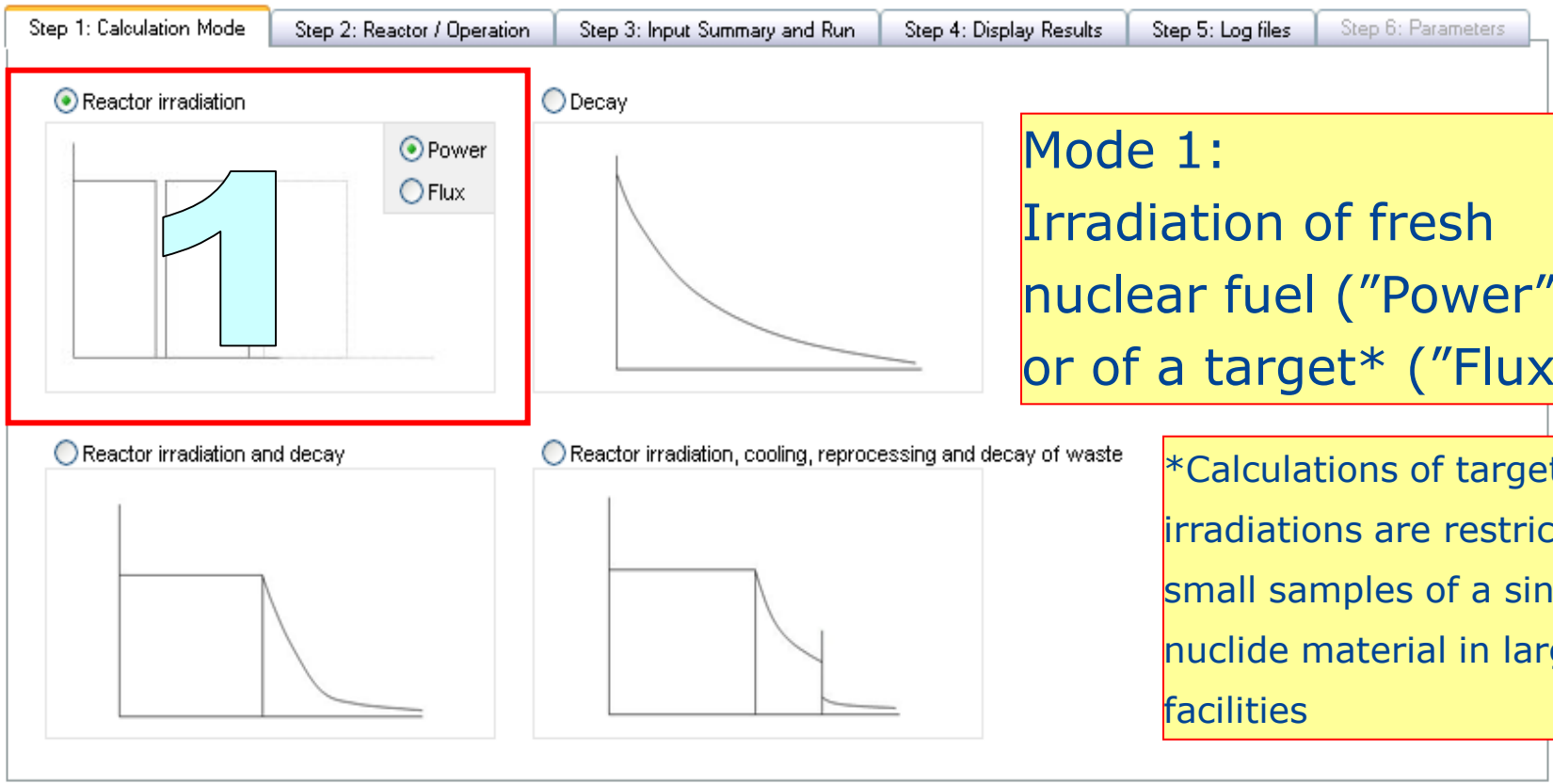
STEP 1: selecting the computation mode



Each mode requires a different method of calculation and a different input parameter set up

webKORIGEN calculations step by step

STEP 1: selecting the computation mode

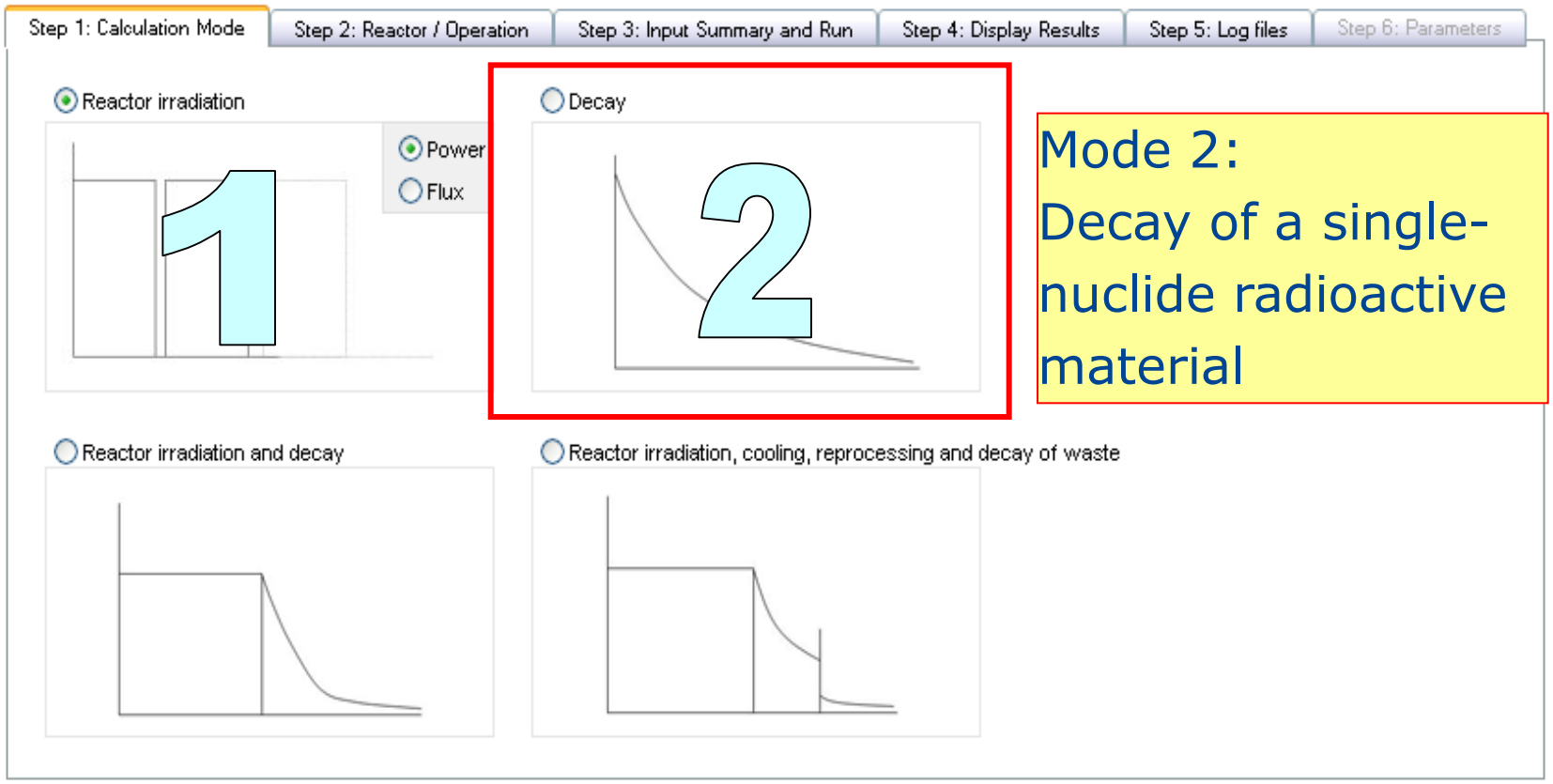


Mode 1:
Irradiation of fresh nuclear fuel (”Power”) or of a target* (”Flux”)

*Calculations of target irradiations are restricted to small samples of a single-nuclide material in larger facilities

webKORIGEN calculations step by step

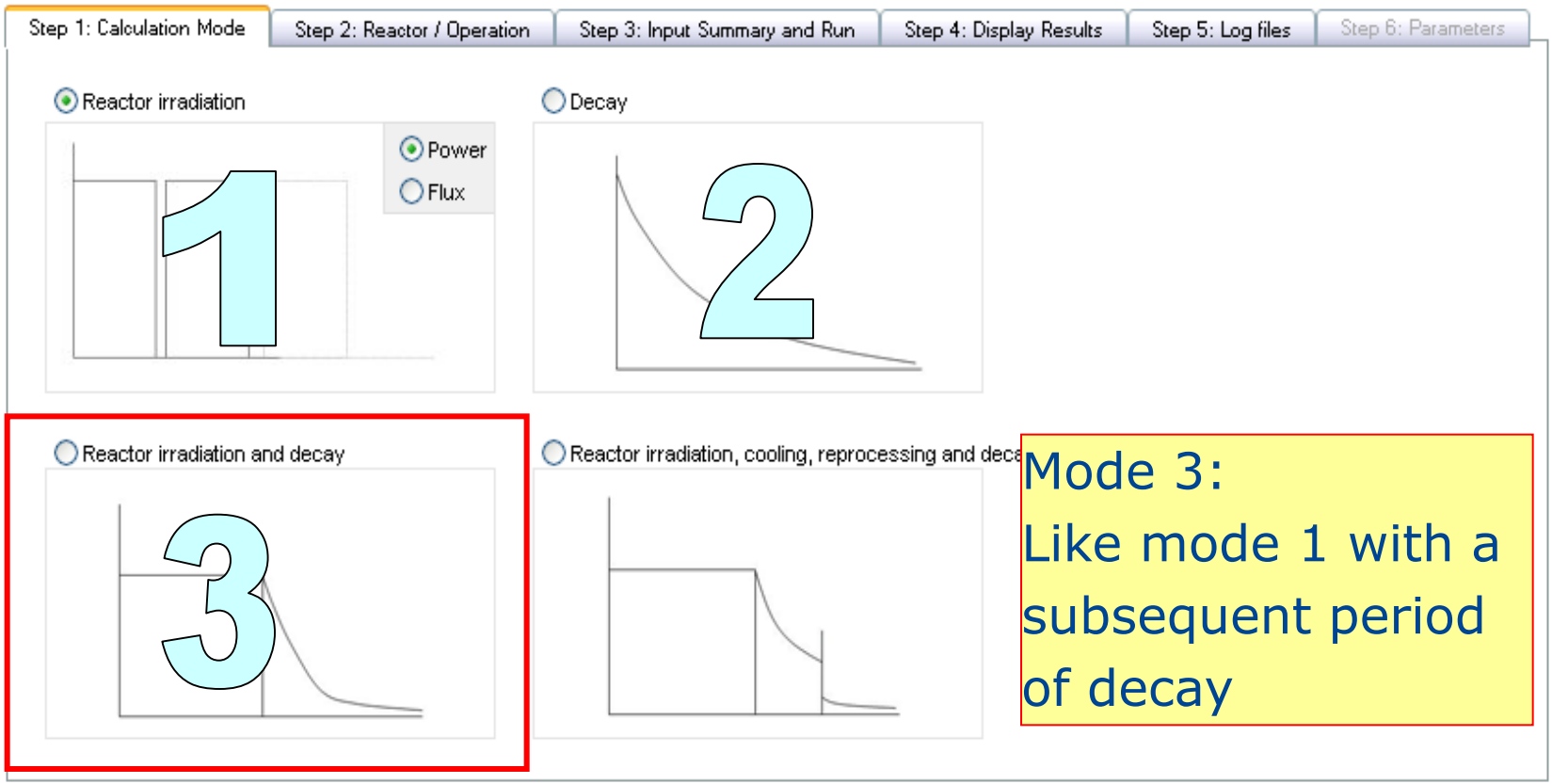
STEP 1: selecting the computation mode



Mode 2:
Decay of a single-nuclide radioactive material

webKORIGEN calculations step by step

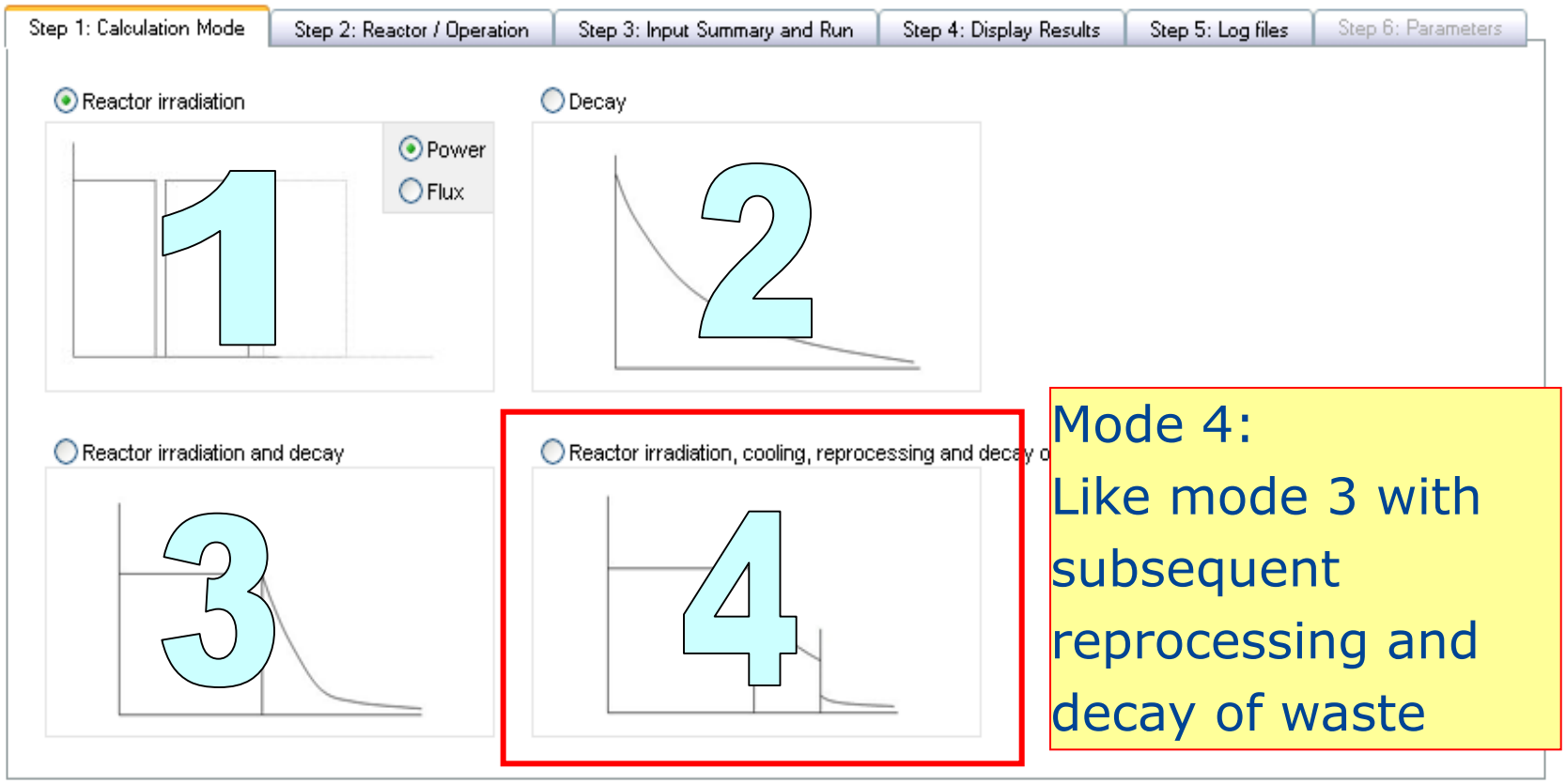
STEP 1: selecting the computation mode



Mode 3:
Like mode 1 with a subsequent period of decay

webKORIGEN calculations step by step

STEP 1: selecting the computation mode



Mode 4:
Like mode 3 with subsequent reprocessing and decay of waste

webKORIGEN calculations step by step

STEP 2 : set up of mode-dependent input parameters

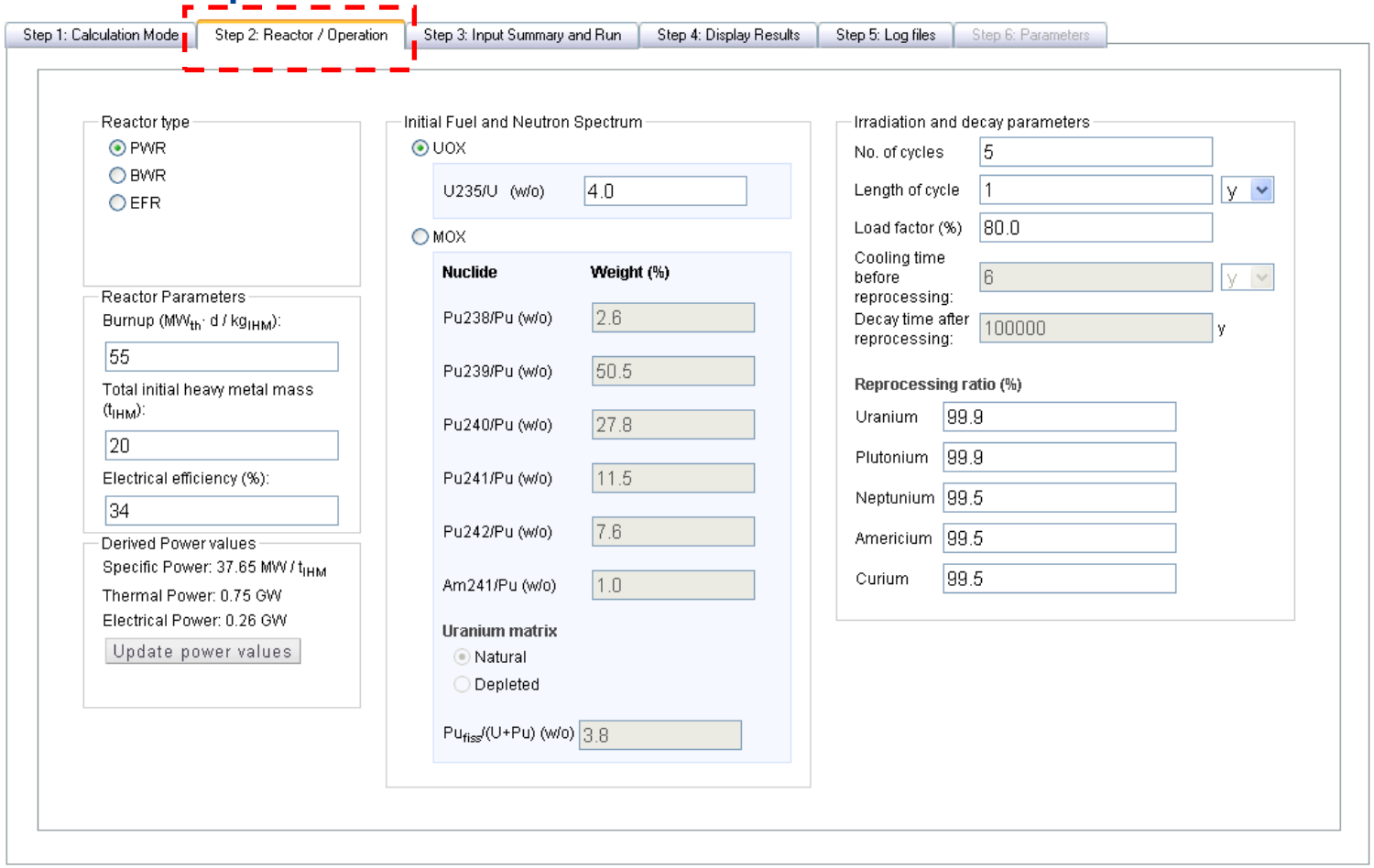
Modes 1, 3 and 4 start with an irradiation phase, for which the reactor type, the fuel type, and the irradiation history have to be set up.

Reactor types supported by webKORIGEN:

- Thermal power plants
  - Pressurized Water Reactors (PWR)
  - Boiling Water Reactors (BWR)
  - European Fast Reactor (EFR) - a future extension to the current industrial technology

webKORIGEN calculations step by step

STEP 2 : set up of input parameters for mode 1 – an example



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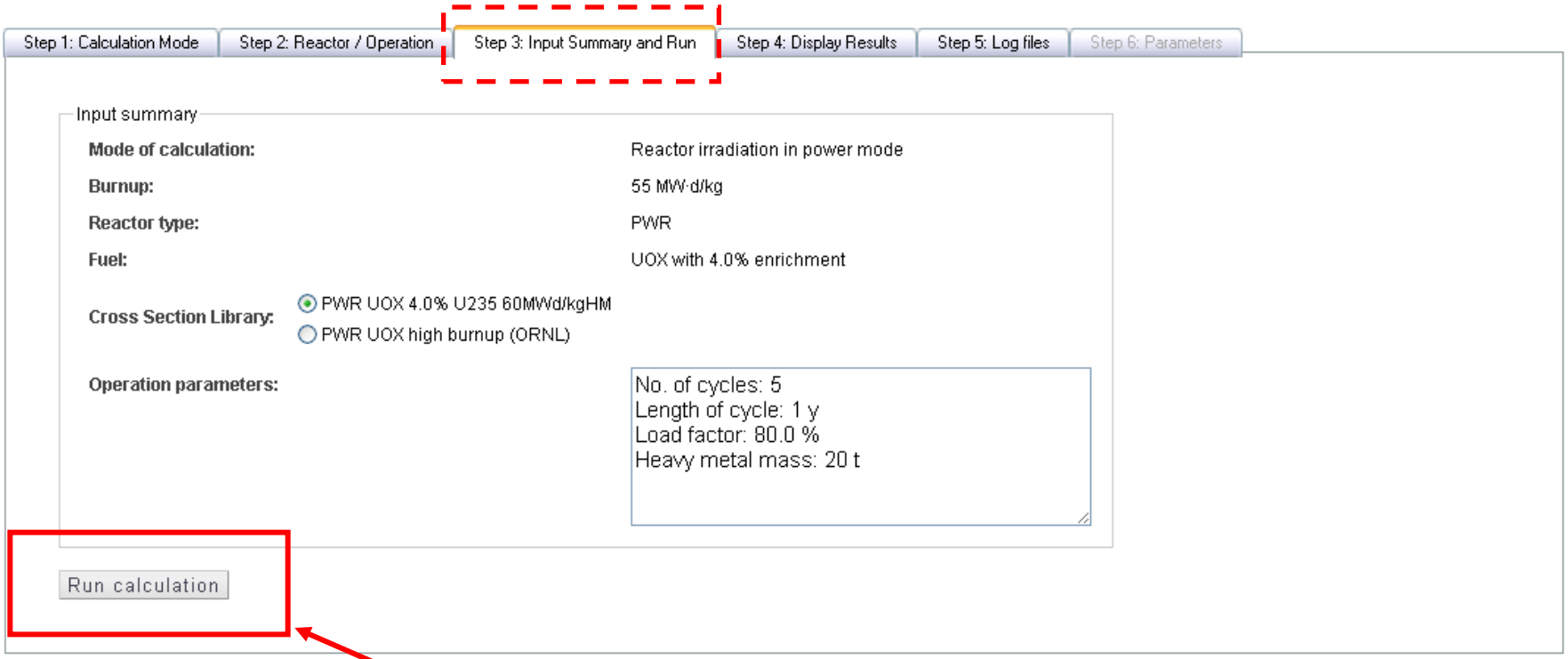
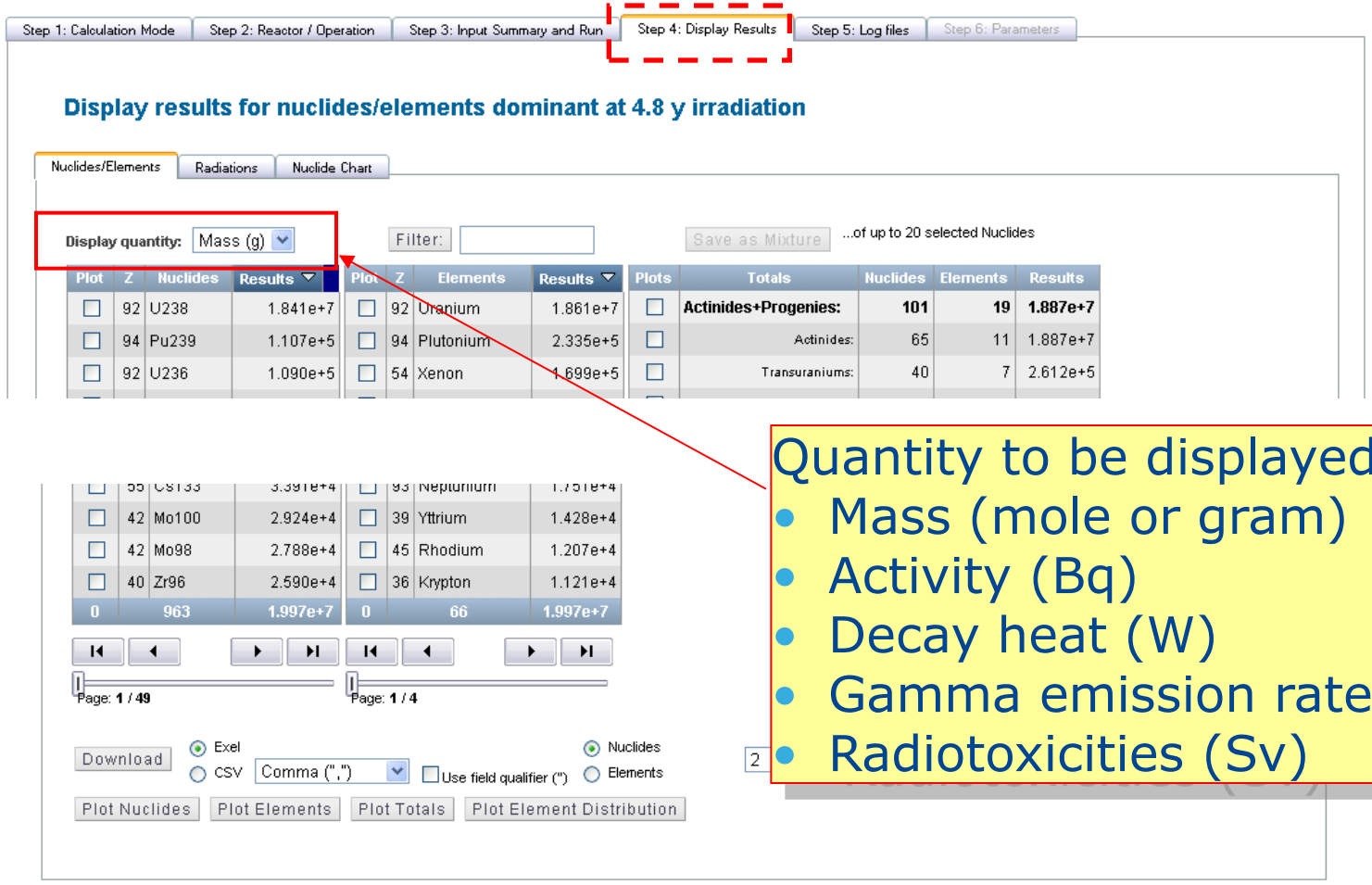
STEP 3 : Display of input summary and start of the execution



Run calculation

webKORIGEN calculations step by step

STEP 4: Display results – example: output in tables

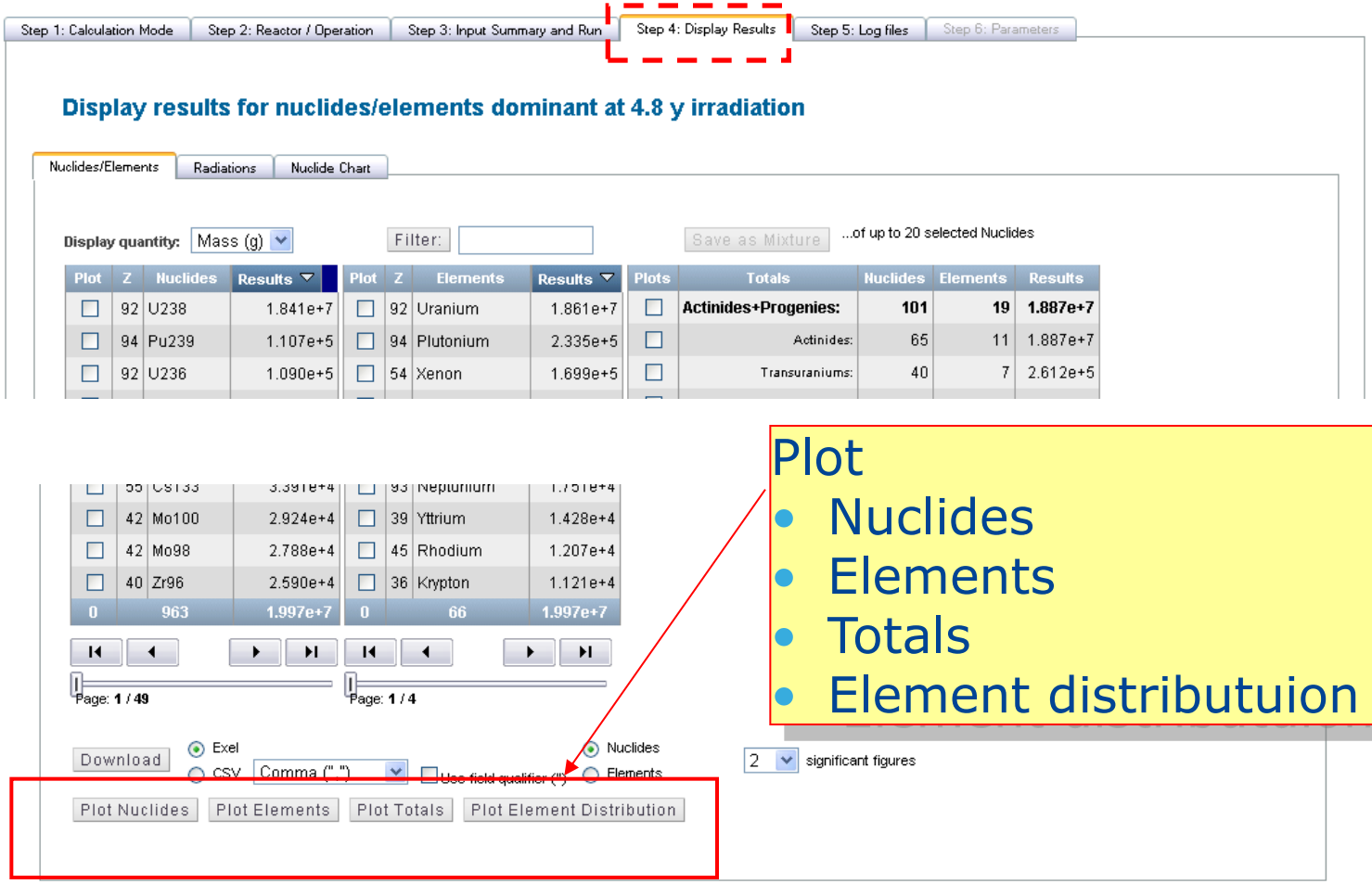


Quantity to be displayed

- Mass (mole or gram)
- Activity (Bq)
- Decay heat (W)
- Gamma emission rate (W)
- Radiotoxicities (Sv)

webKORIGEN calculations step by step

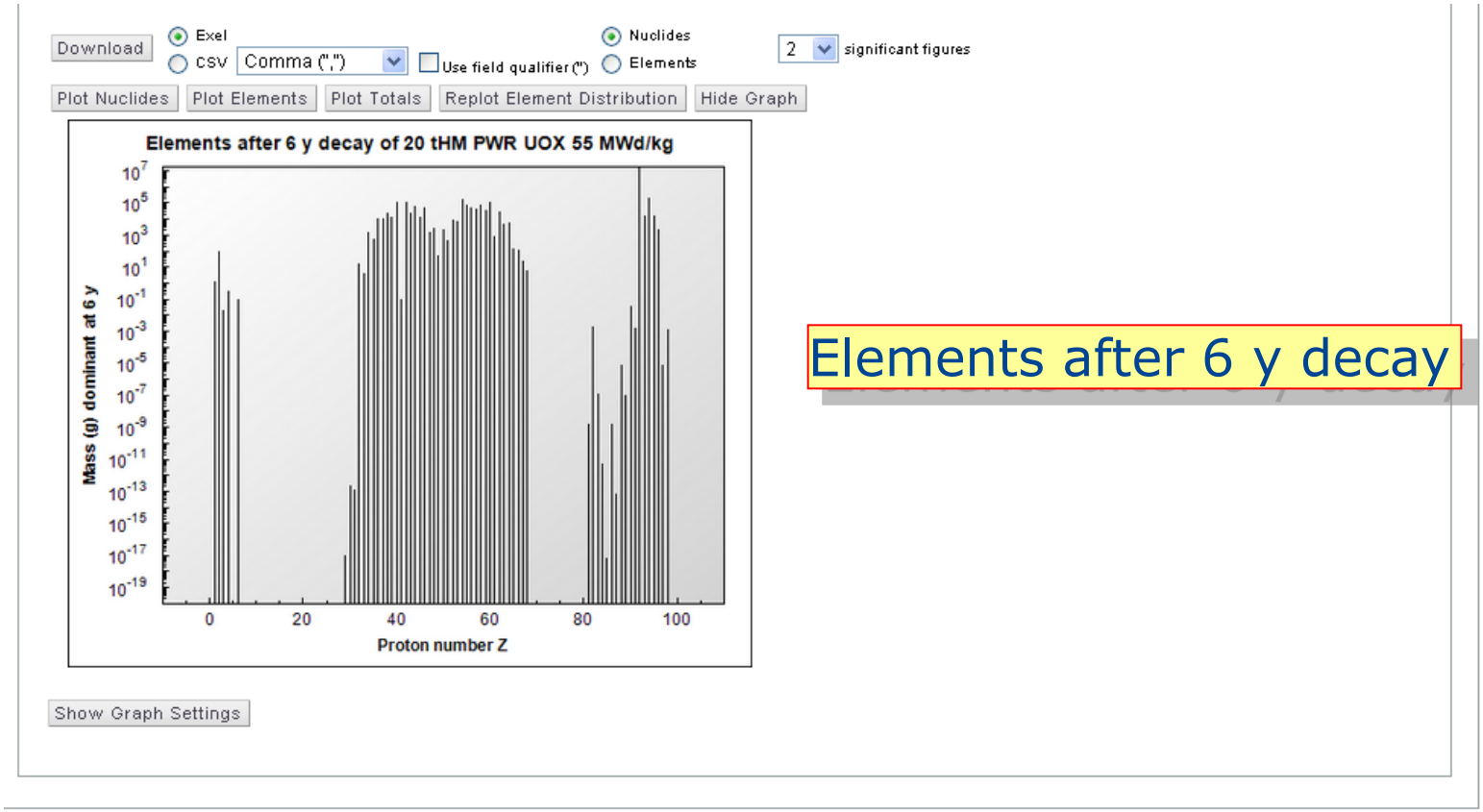
STEP 4: Display results – example: output in graphs



Plot
- Nuclides
- Elements
- Totals
- Element distributuion

webKORIGEN calculations step by step

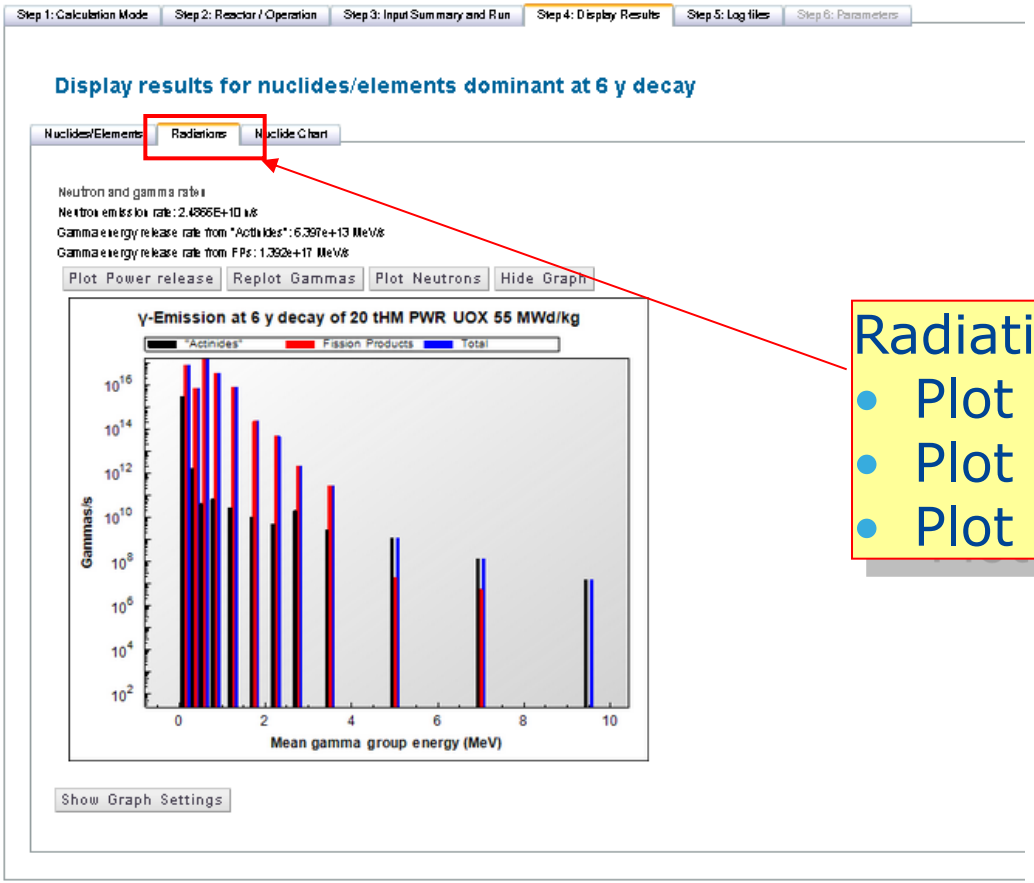
STEP 4: Display results – example: output in graphs



Elements after 6 y decay

webKORIGEN calculations step by step

STEP 4: Display results – example: output in graphs

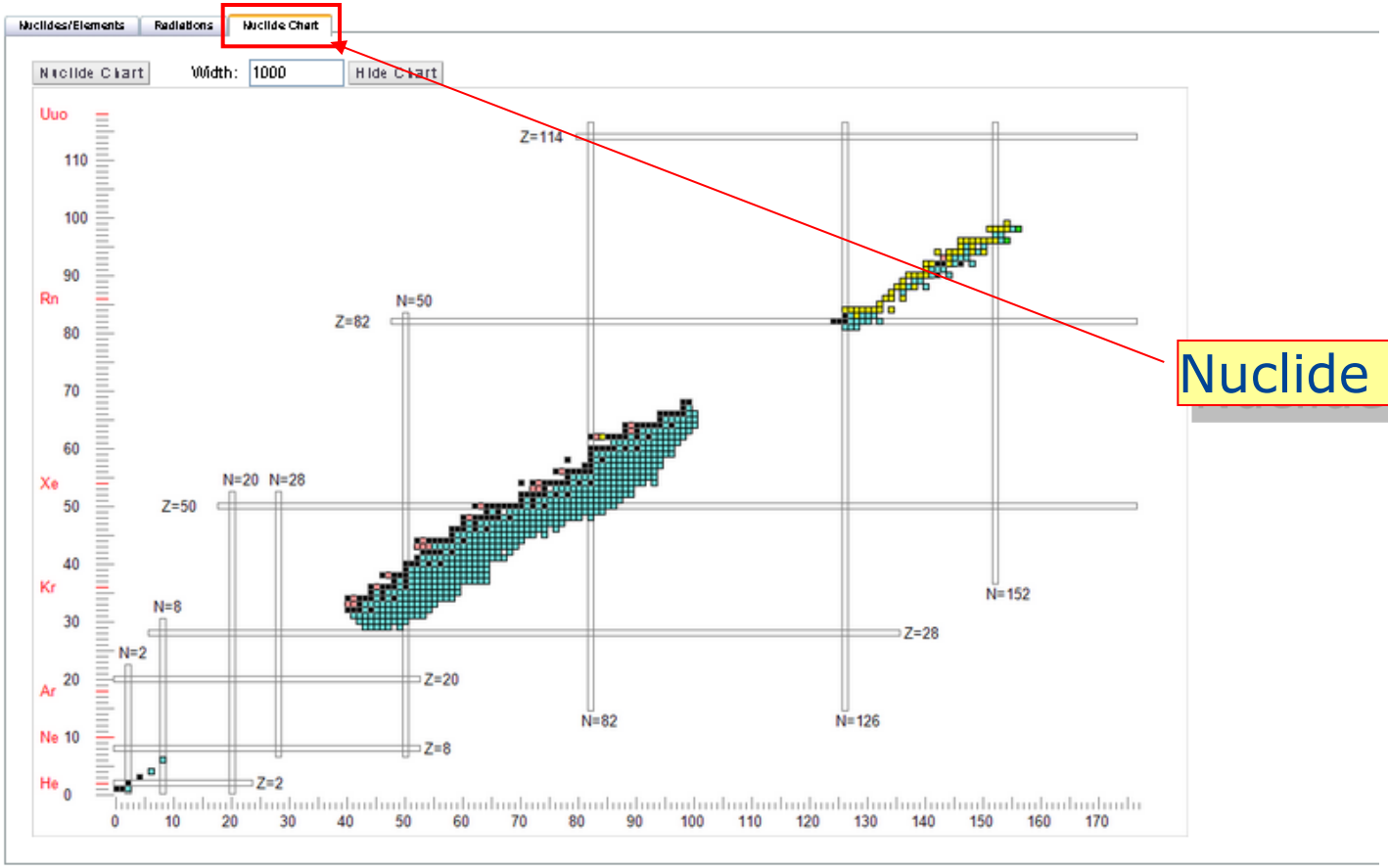


Radiations

- Plot power release
- Plot gammas
- Plot neutrons

webKORIGEN calculations step by step

STEP 4: Display results – example: output in graphs



Nuclide chart

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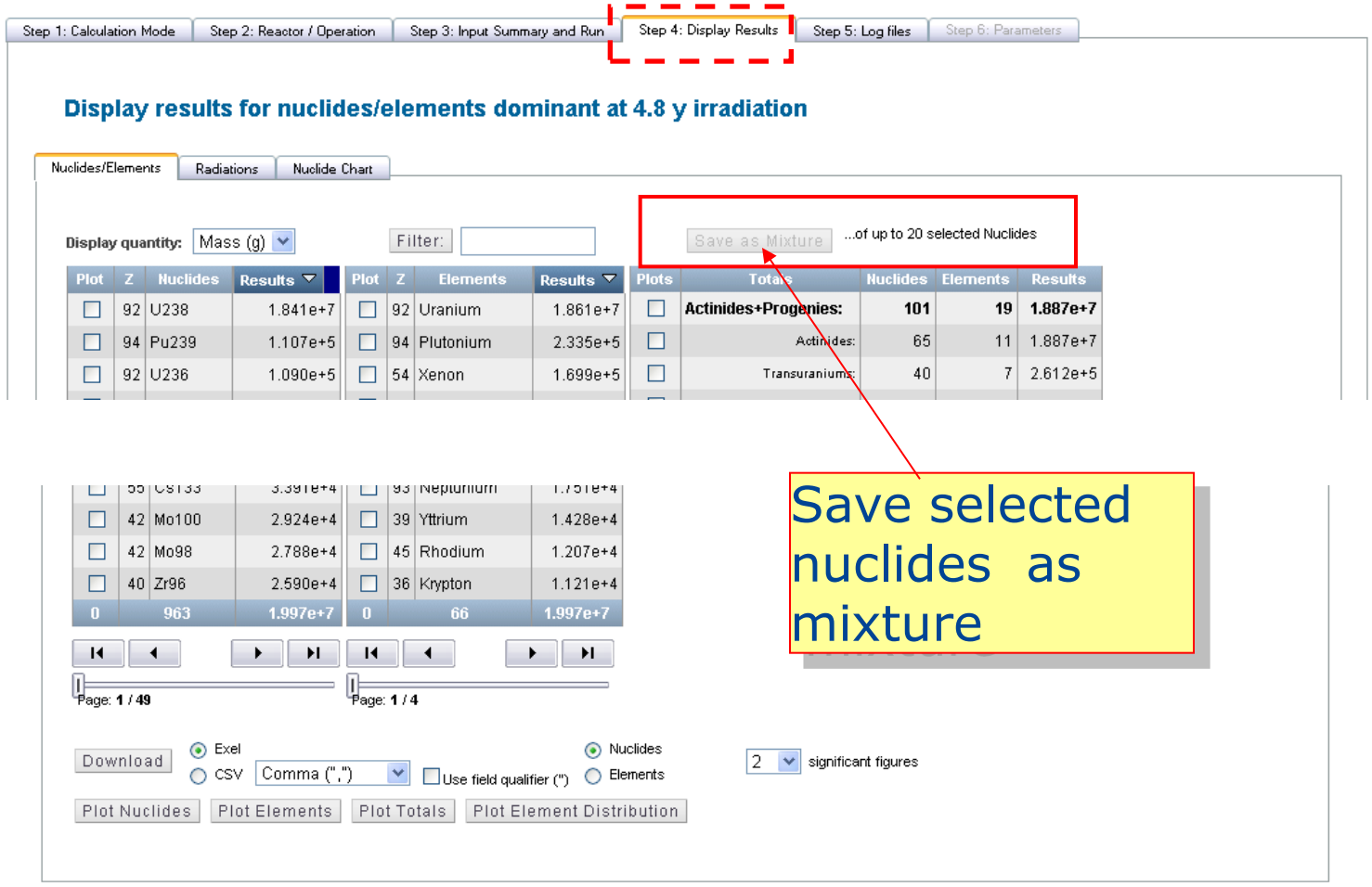
webKORIGEN calculations step by step

STEP 4: Display results – example



Exercise 1

Following the irradiation of UO_2 fuel in a PWR and 30 years cooling, calculate the activities of Cs137 and Sr90 fission products (show a graph of activities over the 30 y period)

1. Calculation mode: "Reactor irradiation and decay"
2. Reactor operation:
   - Reactor type: PWR
   - Fuel: UOX with default enrichment (4.0 %)
   - Irradiation and decay parameters:
     - Fuel decay time after discharge: 30 years
   - default values for burn-up, number of cycles etc.
3. Run calculation
4. Examine results: Display quantity: Activity (Bq)
5. Select Cs137 and Sr90 in the table
6. Plot nuclides

Exercise 2

Calculate the fission yield of Ba139 from the irradiation of 1g U235 (from enriched uranium) in a thermal neutron spectrum (flux $7x10^{11}$ cm^2s-1) during 30 minutes (show a graph of the mass of Ba139 produced during the 30 minute irradiation).

1. Calculation mode: "Reactor irradiation (Flux)"
   - Flux=7E11
2. Reactor operation:
   - Reactor type: PWR
   - Fuel: UOX with default enrichment (4.0 %)
   - Single nuclide irradiation: U235
   - Initial mass: 1g
   - Irradiation time: 3 min
3. Run calculation
4. Examine results: Display quantity: Mass (g)
5. Select Ba139
6. Plot nuclides

Exercise 3

Dose rate from spent fuel after 6 years cooling

1. Set up a “Reactor irradiation and decay” calculation for a PWR reactor with UOX, using default values for burn-up, fuel enrichment, number of cycles etc.
2. Run calculation
3. Examine results
4. Select the top 20 nuclides with highest gamma emission rates and save them as a nuclide mixture
5. Go to the *Dosimetry and shielding* application
6. In the mixture selector select “webKorigen nuclides”
   - Include daughters!
7. Do a dose rate calculation as usual